A short-term survival rate of Astra Tech implants
: a retrospective analysis

Jung-Soo Kim
Department of Dentistry
The Graduate School, Yonsei University

A short-term survival rate of Astra Tech implants
: a retrospective analysis

Directed by Professor Seong-Ho Choi

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This certifies that the Master's thesis of

Jung-Soo Kim is approved.

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Thesis Supervisor : Seong-Ho Choi

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Chang-Sung Kim

_____

Ui-Won Jung

The Graduate School

Yonsei University

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감사의 글

본 논문이 완성되기까지 부족한 저에게 지도와 격려를 아끼지 않으신 최성호 교수님, 김창성 교수님, 정의원 교수님께 깊은 감사를 드립니다. 그리고 부족한 논문임에도 진심 어린 조언으로 격려해주시고 따뜻한 관심으로 지켜봐 주신 김종관 교수님, 채중규 교수님, 조규성 교수님, 박정철 교수님, 이중석 교수님께 감사드립니다.

연구 내내 많은 도움을 준 치주과 수련의 선생님들, 그리고 때늦은 공부에 많은 조언을 주신 대학원 선, 후배님들께 모두 진심으로 감사드립니다.

마지막으로 어려움이 있을 때마다 항상 저의 버팀목이 되어주시고, 물심양면으로 도움을 주신 아버지, 어머니와 장인, 장모님께 깊은 사랑과 감사를 드리며, 무엇보다도 아이들 돌보며 늦깎이 학생 뒷바라지 하느라 고생한 제 인생의 가장 좋은 친구이자 동반자인 아내에게도 저의 온 마음을 담아 감사와 사랑을 전합니다.

2011년 12월

저자 씀

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ABSTRACT

A short-term survival rate of Astra Tech implants : a retrospective analysis

Jung-Soo Kim, D.D.S.

Department of Dentistry

The Graduate School, Yonsei University

(Directed by Professor Seong-Ho Choi, D.D.S., M.S.D., PhD.)

The aim of this study was to analyze the short-term predictability and reliability of Astra Tech implants according to the demographical distribution of patients and condition of implant sites and location of implants.

Among patients treated with Astra Tech implant (Astra Tech AB) in the Department of Periodontics at the Dental Hospital of Yonsei University Health System and K Dental Clinic from May 2004 to March 2009, 195 implants in 98 patients which had been elapsed more than 6 months after prosthodontic procedures were evaluated in this study. Following data were reviewed from patient charts and implants survival rate was examined: 1) patient type and implant location, 2) bone status at the implant site, 3) diameter and length of

the placed implants, 4) presence or absence of bone augmentation and types of the augmentation.

The results from this study are as follows: 1) most implants were placed in the molar area, especially 1st molar area of maxilla, 2) most implants were placed at D2 and D3 bone type, 3) most implants were placed in areas of B and C bone quantity, 4) autogenous and alloplastic bone graft and barrier membrane were used for placement of 74 implants.

As a result, a short-term survival rate of Astra Tech implants was 100%. Therefore, the short-term predictability and reliability of Astra Tech implants are determined by a satisfactory level. Especially, even if bone augmentation procedures are performed in poor bone condition, the initial stability of Astra Tech implant represented by the above results will be a reliable basis in implant selection of patient and dentist.

Key Words: Dental implantation, Humans, Retrospective studies, Survival rate.

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I. INTRODUCTION

In 1981 Albrektsson et al. emphasized the biocompatibility, macro, and micro-morphology of implant, surface treatment of implant, condition of recipient site, surgical technique, and control of loading condition as key factors of successful osseointegration in dental implants. They also reported other factors needed for successful implant therapy such as patient selection, experience of the surgeon, initial stability of the implant, placement timing, esthetics, and responsiveness to the grafting material (Baier et al., 1988; Smith, 1988; Chiarenza, 1989; Tatum and Lebowitz, 1991). Clinically, obtaining

sufficient initial stability is crucial. This depends on the bone density of the surgical site, the surgical method, and the microscopic surface characteristics and macroscopic morphology of the implants (Martinez et al., 2001)

Among various factors in predicting the success of implant therapy, factors determined by the patient are the volume and density of available bone (Atwood, 1963; Brånemark et al., 1985). The atrophy of available bone after extraction limits the length and diameter of the implant. Initial stability is weakened by decreased bone density, which in turn affects implant success. Many previous studies have shown that placement of short implants due to severe bone loss at the implant site resulted in an increased failure rate. Bone density is usually decreased after tooth loss and this also has an effect on implant success (Collaert and De Bruyn, 1998; Cochran et al., 2002; Lekholm et al., 2006; Misch et al., 2008).

Assuming an acceptable level of surgeon's experience and patient's bone quality, reliable implants will result in a more predictable outcome. Therefore, the success rate of implants in the implant system is considered a measure of reliability. Since Schnitman and Shulman (1979) proposed success criteria for implants, several criteria have been proposed (Smith and Zarb, 1989; Buser et al., 1990), and the report by Albrektsson et al. (1986) is most widely used.

However, recent studies have been conducted on implants with

immediate placement or early-loading protocols. It is difficult to compare the two types of studies in analyzing their survival or success rates. Carr et al. (2003) reviewed 674 1-stage implants with a 78-month follow-up period. In this retrospective study, the implant survival rate was determined by means of Kaplan-Meier survival estimates. No failures were noted 13 months after placement. Penarrocha et al. (2007) reported a 1-year survival rate for a single implant with early loading within 6-8 weeks after placement. Buser's survival criteria (1990) and the Kaplan-Meier survival estimates were used to compare these results with the survival rates of other implants with early loading. Many studies have considered 1 year after implant placement to be a critical point because the Kaplan-Meier survival curve almost reaches a plateau 1 year after the implant placement. Performance of bone augmentation did not affect the implant success rate or the amount of marginal bone loss (Schliephake et al. 1997; Becktor et al., 2004; Finne et al., 2007).

Until recently, various implant systems have been introduced to increase the success rate and research on implant design and surface treatment has been actively performed (van Steenberghe et al. 2000; Cochran, 1999). Many studies have revealed that the success rate is higher in rough-surfaced implants by various surface treatments than in smooth-surfaced implants by machining (Li et al., 1999; Botticelli et al., 2005). Regarding the morphology of the

implants, the initial stability was enhanced by self-tapping implants and the success rate was also increased (Rosenlicht , 2002; Davarpanah et al., 2002).

The Astra Tech implants reviewed in this study have a microthreaded conical neck and TiO blast surface (Figure 1) (Palmer et al., 1997). Microthreads on the fixture top prevent concentration of the stress around the alveolar ridge crest and decrease marginal bone loss (Lee et al., 2007). The fixture and abutment are strongly connected at an 11.5 degree angle by the conical seal design. The conical design seals off the connection and decreases micro-movement and micro-leakage (Norton, 1999; Harderet al., 2010). In 1998 Norton documented a statistically significant decrease in the bone loss around Astra Tech implants after 4 years of radiographic assessment. Palmer et al. (2000) found an average 0.39 mm bone loss in a 5-year prospective study in 2000. Shin et al. documented a smaller degree of bone loss in implants with microthreading regardless of bone quality in a 1-year prospective comparative study in 2003. A statistically significant difference was found, especially in the maxilla.

The aim of this study was to analyze the short-term predictability and reliability of Astra Tech implants according to the demographical distribution of patients and condition of implant sites and location of implants.

II. MATERIALS AND METHODS

1. Subjects and materials

Among patients treated with Astra Tech implants in the Department of Periodontics at the Dental Hospital of Yonsei University Health System and K Dental Clinic from May 2004 to March 2009, 195 implants in 98 patients which had been elapsed more than 6 months after prosthodontic procedures were reviewed in this study (Table I).

The intraoral locations of the Astra Tech implants are as shown in Table II.

The diameters of Astra Tech implants were 3.5 mm, 4.0 mm, 4.5 mm, and 5.0 mm. The lengths of the implants varied widely, and ranged from 8 mm to 13 mm (Tables III and IV).

This study was approved by the Institutional Review Board of Dental Hospital of Yonsei University of College of Dentistry (IRB number 2-2011-0014).

2. **Methods**

The following data were reviewed from patient charts: 1) patient type and

implant location, 2) bone status at the implant site, 3) diameter and length of the placed implants, 4) presence or absence of bone augmentation and types of the augmentation. The implant success rate was then examined in light of these variables.

Before implant placement, every patient went through oral and radiographic examinations. A medical history was also taken and smoking habits were reviewed. Implants were not placed in patients with an absolute contraindication that could not be controlled. In those patients, the edentulous areas were given an alternative treatment. Patients were also interviewed about the cause and timing of the extraction to determine the types of tooth loss by age and sex.

The bone status at the implant site was documented according to Lekholm and Zarb's classification (2006). Bone quality and bone quantity was evaluated during surgery. The diameter and length of the implants placed were reviewed from the patient charts.

Using the patient charts, the surgical procedures (1-stage or 2-stage implant placement procedure), additional bone augmentation procedures, and graft materials (such as bone or artificial membrane) were reviewed. The time until completion of prosthodontic treatment after implant installation was also investigated. In addition, the follow-up data (including patient interviews and

oral and radiographic examinations) older than 6 months after prosthodontic treatment were evaluated.

3. **Assessment method**

The survival criteria were based on those proposed by Buser et al. in 1997 and by Cochran et al. in 2002. The criteria includes: 1) the absence of clinical mobility of the implants, 2) the absence of subjective sensitivity or pain, 3) the absence of peri-implantitis, and 4) the absence of persistent radiolucency around the implants.

III. RESULTS

One hundred and ninety-five implants were evaluated in this study. Regarding implant length, 11 mm was the most common (47%). With respect to the diameter of implants, 4 mm occupied the largest portion (35%), followed by 5.0 mm (30%), 3.5 mm (25%), and 4.5 mm (10%). This is because implant diameter is restricted by the bucco-lingual width of the available bone and the relationship with adjacent teeth (Collaert and De Bruyn, 1998; Yoo et al., 2002).

Fifty-five implants (28%) were applied using a 1-stage implant placement procedure, and the other 140 implants (72%) using a 2-stage procedure. Also, for 74 implants in surgical sites with poor bone quality or quantity an additional bone augmentation procedure, such as sinus augmentation or the guided bone regeneration procedure, was used. Prosthodontic treatment was completed by 2 to 20 months after implant installation with a mean of 5.9 months.

1. Survival rate according to implant location

Most implants were placed in the molar area, especially the 1st molar

area of the maxilla, and there was no difference in the survival rate according to the implant location (Table V).

2. **Survival rate according to bone quality**

Most implants were placed in D2 and D3 bone types, and there was no difference in survival rate according to bone quality (Table VI).

3. **Survival rate according to bone quantity**

Most implants were placed in areas of B and C bone quantity, and there was no difference in survival rate according to bone quantity (Table VII).

4. **Survival rate according to the presence or absence of bone augmentation procedure**

An autogenous bone graft, allograft, or alloplast with artificial membrane were used for placement of 74 implants. Maxillary sinus elevation procedures were performed for the placement of 33 implants in the maxillary posterior region. Nevertheless, there was no difference in the survival rate (Table VIII).

IV. DISCUSSION

Since the introduction of the concept of osseointegration by Branemark in the early 1960s, implant therapy has been a commonplace for replacing edentulous areas in daily practice. Up to now, implants with various shapes, designs, and surface treatments have been introduced. In the Department of Periodontics at the Dental Hospital of Yonsei University Health System, 4,500 implants were placed for approximately 10 years from 1992 to 2002, and based on these patient records, basic assessments have been undertaken regarding patient type and distribution of implant location (Hong et al., 2002). Among various implant systems, the microthreaded and conical seal design of the Astra Tech implant has shown lower marginal bone loss around implants, as well as less microleakage and micromovement (Palmer et al., 1997; Lee et al., 2007; Norton . 1999; Harder et al., 2010; Palmer et al., 2000; Shin et al., 2003; Hansson and Norton, 1999), thus increasing the long term success rate.

In this study, 195 Astra Tech implants were placed in 98 patients in the Department of Periodontolgy at the Dental Hospital of Yonsei University of College of Dentisry and in K Dental Clinic. Based on these data, the short-term survival rate of Astra Tech implants was evaluated by considering bone quality, bone quantity, and bone augmentation procedures.

In 1985, Brånemark et al. classified the bone status around the implant surgery area. This has been used by many clinicians to predict treatment outcomes. In this study, the bone quality and bone quantity were separately evaluated. With respect to bone quality, the predominant bone type was D3 in the maxilla and D2 in the mandible. With regard to bone quantity, type B and C occupied most cases (96%) of the maxilla and type B was predominant in the mandible (73%). We often encounter situations where the bone quantity is deficient in an edentulous area. To place implants with sufficient length and diameter in these areas, a bone graft with autogenous bone or alloplastic material with or without a membrane are required. Additional procedures are also necessary, especially in the maxilla, such as in maxillary sinus elevation. Currently, the development of these procedures has contributed to a high success rate of implants, and implants can be placed in more challenging cases (Buser et al., 1990).

In 1997, Kemppainen et al. reported that the short-term survival rate of Astra Tech implants is 97.8%, and in 2004, Norton reported that it is 96.4%. In this study, the short-term survival rate was 100% regardless of bone quality, bone quantity, or use of bone augmentation procedures. And, the mean marginal bone loss of implants in which augmentation procedures were performed and prosthodontic procedures were finished in this study is 0.11

mm (average period of treatment: 6.8 months), which is less than 0.39 mm reported by Palmer et al. in 2000. Rather, the cases that marginal bone level has increased were considerable (Fig. I). These high short-term survival rates and low marginal bone loss are due to the distinctive fixture design of the Astra Tech implant, which results in excellent initial bone responses. Therefore, the use of an Astra Tech implant can result in predictably good treatment results even if the bone quality is poor and bone augmentation is necessary because of poor bone quantity. Also, this initial stability of Astra Tech implant will be a reliable basis in implant selection of patient and dentist.

V. CONCLUSION

The patient type, distribution of implant locations, and survival rate of Astra Tech implants were investigated in this study and following was concluded:

1. The short-term survival rate of Astra Tech implants was 100%.

2. Bone quality was in the decreasing order of D3 (55%) >D2 (28%) >D4 (16%) >D1 (0%) for the maxilla and D2 (77%) >D3 (18%) >D4 (4%) >D1 (1%) for the mandible with a 100% survival rate.

3. Bone quantity was in the decreasing order of Type B (51%) >C (49%) >D (3%) >A (1%) for the maxilla and Type B (73%) >C (18%) >D (5%) >A (4%) for the mandible with a 100% survival rate.

4. Bone augmentation was carried out in 38% of implants placed, with 100% survival rate.

Considering the consistent outcomes mentioned above, Astra Tech implants can be reliably used in daily practice. If additional bone augmentation procedures are performed to improve the bone quality and quantity in areas where the bone condition is not optimal, acceptable treatment results can be expected.

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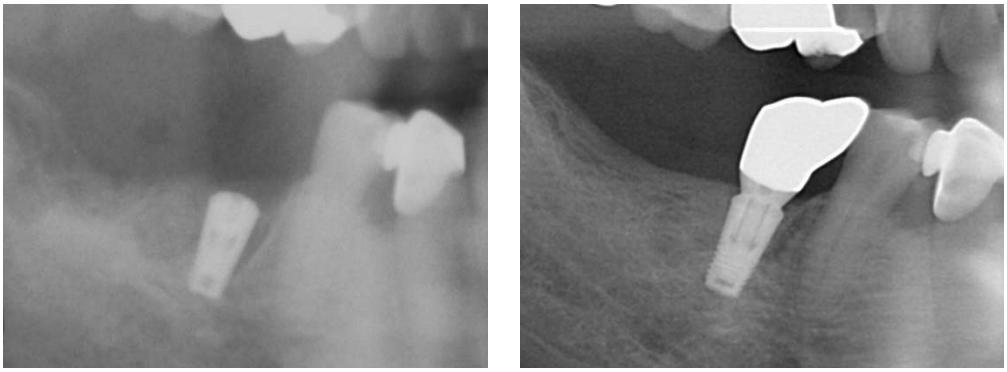
Legends

Figure 1. Clinical radiographs of Astra Tech Implant (Astra Tech AB, Molndal, Sweden)

A. After implant installation. (November 2004)

B. At 54 months follow-up check. (May 2009)

Figure



A B

Figure 1

Tables

Table I. Distribution according to patient's age and sex

Age (years)	Male		Female		Total (%)	
	No. Implants	No. Patients	No. Implants	No. Patients	No. Implants	No. Patients
<30	8	7	10	9	18	16
30~39	9	5	7	3	16	8
40~49	35	13	24	17	59	30
50~59	37	15	13	9	50	24
60≤	24	9	28	11	52	20
Total	113	49	82	49	195	98

Table II. Distribution of placed implants according to the location

No. Implants	0	5	23	7	7	6	4	5	7	4	5	5	10	20	8	0
Tooth number	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Tooth number	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
No. Implants	0	15	20	6	2	0	3	2	0	5	2	0	6	9	9	0

Table III. Distribution of implant length

length (mm)	Mx.		Mn.		Total (%)
	Ant.	Post.	Ant.	Post.	
8	0	5	0	4	9 (5)
9	0	35	0	22	57 (29)
11	12	33	7	39	91 (47)
13	19	12	5	2	38 (19)
Total	31	85	12	67	195 (100)

Mx: Maxilla, Mn: Mandible, Ant: Anterior, Post: Posterior

Table IV. Distribution of implant diameter

Diameter (mm)	Mx.		Mn.		Total (%)
	Ant.	Post.	Ant.	Post.	
3.5	21	11	10	7	49 (25)
4.0	7	33	2	26	68 (35)
4.5	2	10	0	7	19 (10)
5.0	1	31	0	27	59 (30)
Total	31	85	12	67	195 (100)

Mx: Maxilla, Mn: Mandible, Ant: Anterior, Post: Posterior

Table V. Survival rate (SR) of implants according to location

	central incisor	Lateral incisor	canine	1st PM	2nd PM	1st molar	2nd molar	3nd molar	Total
Mx.	12	8	11	12	17	43	13	0	116
Failure	0	0	0	0	0	0	0	0	0
SR	100	100	100	100	100	100	100	100	100
Mn.	2	8	2	2	12	29	24	0	79
Failure	0	0	0	0	0	0	0	0	0
SR	100	100	100	100	100	100	100	100	100

Mx: Maxilla, Mn: Mandible, PM: Premolar, SR: Survival rate

Table VI. Survival rate (SR) of implants according to bone quality

Bone quality	N		Failure	SR (%)
	Upper	Lower		
D1	0	1	0	100
D2	33	61	0	100
D3	64	14	0	100
D4	19	3	0	100
Total	195		0	100

N: Number, SR: Survival rate

Table VII. Survival rate (SR) of implants according to bone quantity

Bone quantity	N		Failure	SR (%)
	Upper	Lower		
A	1	3	0	100
B	59	58	0	100
C	52	14	0	100
D	4	4	0	100
Total	195		0	100

N: Number, SR: Survival rate

Table VIII. Number of advanced techniques on the recipient site

		Maxilla	Mandible	Total	SR (%)
[Sinus Augmentation]		33	-	33	100
crestal approach		12	-	12	
lateral approach		21	-	21	
[GBR]		32	9	41	100
autogenous bone		14	3	17	
MBCP*	+ GTAM+	3	2	5	
	+ CollaTape+++	2	0	2	
Osteon**	+ GTAM+	3	1	4	
	+ CollaTape+++	4	2	6	
Oragraft***	+ GTAM+	1	0	1	
	+ BioGide++	5	1	6	
Total		65	9	74 (38%)	100

SR: Survival rate, GBR: guided bone regeneration

* MBCP (Biomatlante, Vigneux de Bretagne, France)

** Osteon (Dentium, Suwon, Korea)

*** OraGraft (LifeNet Health, Virginia, U.S.A.)

\+ GTAM (Gore-Tex Augmentation Material membrane; WL Gore, Flagstuff, AZ, USA)

\++ BioGide (porcine type I and III collagen; Geistlich Biomaterials, Wolhusen, Switzerland)

\+++ CollaTape (Zimmer dental, Carlsbad, USA)

국문요약

Astra Tech implant의 후향적 단기 생존율

<지도교수 **최 성 호**>

연세대학교 대학원 치의학과

김 정 수

아스트라(Astra Tech) 임플란트는 인공치근(fixture) 상부의 미세나사산(microthread)와 인공치근(fixture)와 지대주(abutment) 간 conical seal design을 특징으로 하는 대표적인 임플란트이다. 이러한 미세나사산 (microthread)은 임플란트가 받는 힘(stress)이 치조골 상부에 집중시키지 않으므로 변연골의 흡수를 감소시킬 수 있고, conical seal design은 미세 움직임이나 미세 누출을 막아 치료의 장기적 성공율을 높인다고 알려져 있다. 이번 연구는 환자 분포와 임플란트의 위치, 식립부의 상태에 따른 아스트라(Astra Tech) 임플란트의 단기 예지성 및 신뢰도를 알아보기 위해 시행되었다.

2004년 5월부터 2009년 4월까지 “ㅇ” 대학교 치과대학병원 치주과와 “ㄱ” 치과의원에서 임플란트 수술을 받은 환자 중 Astra Tech 임플란트 시스템을 이용하여 시술받은 임플란트 중, 보철 완료 후 적어도 6개월 이상 경과된 98명의 환자 195개의 임플란트를 대상으로 하였다. 환자 차트를 이용하여 다음의 자료를

분석하였고, 임플란트 생존율을 조사하였다. 1) 환자 및 임플란트의 분포와 위치, 2) 임플란트 식립부의 골상태, 3) 식립된 임플란트의 직경 및 길이, 4) 골증대술 유무 및 종류.

조사 결과, 1) 대부분의 임플란트는 구치부, 특히 상악 제1대구치에 가장 많이 식립되었다. 2) 대부분의 임플란트는 D2, D3의 골질에 식립되었다. 3) 대부분의 임플란트는 B, C의 골질에 식립되었다. 4) 74개의 임플란트 식립을 위해 자가골 및 합성골과 함께 차폐막이 사용되어졌다.

결과적으로 아스트라(Astra Tech) 임플란트의 단기 생존율은 100%로 나타났다. 그러므로 아스트라 임플란트의 단기 예지성과 신뢰도는 만족스러운 수준이었다. 특히 골질과 골양이 좋지 않은 부위에 골증대술이 시행된 경우에도 위의 결과가 보여주는 아스트라 임플란트의 초기 안정성은 환자와 술자가 임플란트를 선택함에 있어 신뢰할만한 기준이 될 것이다.

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